

Ch. 8 Cellular Energy

Section 8.1 → How Organisms obtain Energy

I. Transformation

A. Chemical reactions + processes are constantly occurring in your cells

1. All of the cells require energy (ATP), the ability to do work

B. Laws of thermodynamics

1. 1st law = law of conservation of energy
 - a. energy cannot be created nor destroyed

2. Entropy, the measure of disorder, or usable energy

C. Autotrophs + heterotrophs (all organisms need energy to live)

D. Metabolism - all of the chemical reactions in a cell

1. Metabolic pathways include two major types:
 - catabolic + anabolic
 - a. Catabolic - release energy; large → small
 - b. Anabolic - use energy to build large molecules from small molecules

2. Photosynthesis - anabolic pathway in which light energy from the sun is converted to chemical energy

3. Cell respiration - catabolic pathway in which organic molecules are broken down to release energy for cell

II ATP: the unit of cellular energy

A. ATP (Adenosine triphosphate) is the most important biological molecule that provides chemical energy

B. ATP is a nucleotide made of an adenine base, a ribose sugar, and 3 phosphate groups

1. ATP releases energy when the bond between the 2nd and 3rd phosphate groups is broken

a. $ATP \rightarrow ADP$: yields energy

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Cells are made of matter (chemical structures called proteins, carbs, lipids, etc.)

H_2O
CHNOPS

→ What is everything made of?
matter → elements → atoms

→ What are you made of?
mostly H_2O + CHNOPS (elements)

→ How do cells make energy?
Fermentation (no O_2) Cell Resp. (Animals + Plants)

→ What is a heterotroph? Photo (only Plants + Photo Bacteria)
Eats other organisms...

→ What is a food web?
Complete diagram of feeding interactions in a system
MANY food chains → Food web

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→ What is the ultimate source of energy for life?

SUN

→ How is "that" energy converted into a form usable by people? Free Energy

CO_2 → $C_6H_{12}O_6$ → ATP

★ → What is everything made of? ★

Life → Matter → Elements → Atoms → $\frac{p}{n}$ Quarks

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→ How is photosynthesis related to cell respiration?
Which energy processes do plants use? animals?

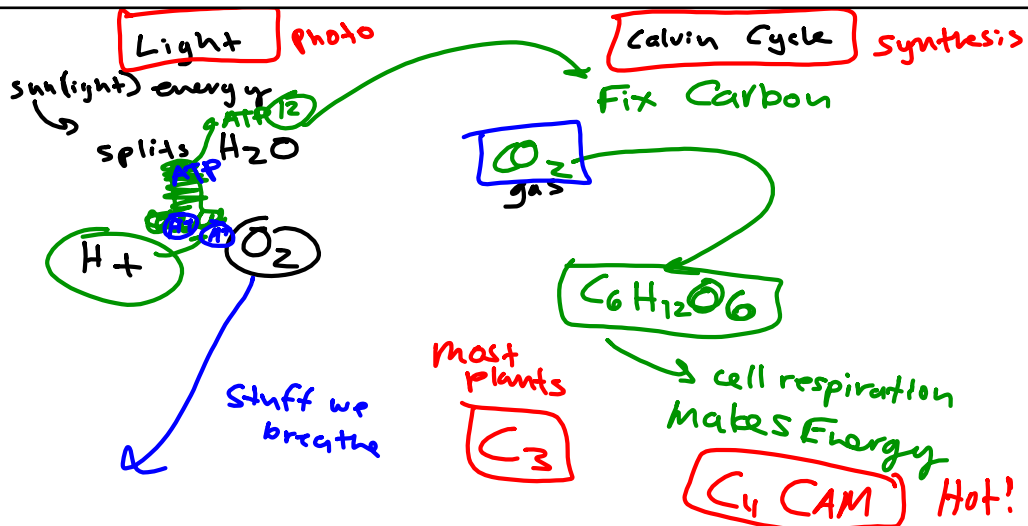


→ What are the first 2 laws of thermodynamics?

1) Energy is not created nor destroyed

2) Entropy (loss of energy (heat) every chemical rxn)

ATP → ADP



Bellringer → No energy

→ How does photosynthesis work? Explain. → makes a sugar
 ★ Draw a diagram ★

→ What is the chemical equation for photosynthesis?

photo
cal
resp

$$\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$$

→ What is metabolism? No Energy

plants
photosynthesis

$$6 \text{CO}_2 + 6 \text{H}_2\text{O} \xrightarrow{\text{(sun) light}} 6 \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2$$

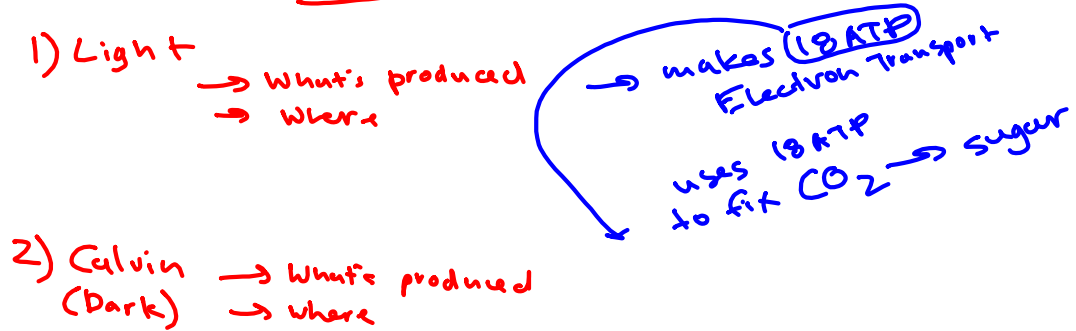
No energy

cellular resp

$$6 \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{Energy}$$

ATP

Photosynthesis



Beltinger

\rightarrow What are the reactants for photosynthesis?

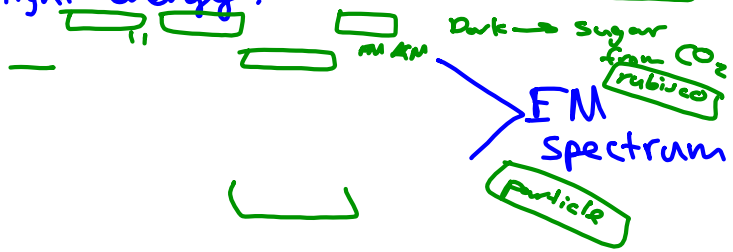


\rightarrow What is light energy's role?
 Radiant \rightarrow chemical energy

\rightarrow What is light energy?

no mass

photon



1 What does the first law of thermodynamics state?

- A entropy increases
- B energy is conserved
- C metabolism decreases
- D chemicals are produced

2 Autotrophs that convert light energy into chemical energy are called _____.

- A heterotrophs
- B chemoautotrophs
- C photoautotrophs
- D omnivores

3 All chemical reactions in an organism's cells are called _____.

- A chemotrophy
- B autotrophy
- C thermodynamics
- D metabolism

4 What chemical bond in ATP releases when broken down?

- A phosphate
- B sulfur
- C oxygen
- D potassium

5 The second law of thermodynamics states....

- A ability to do work is energy
- B spontaneous increase in disorder, entropy
- C the idea that energy cannot be created nor destroyed
- D catabolic pathways break down organic molecules

J .
, "eq1 ran occurs

8.2 Photosynthesis

I. Overview of Photosynthesis energy from sun

A. Equation: $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

B. Occurs in two phases

1. Phase 1 (light-dependent)

a. Electron transport → make energy (ATP)

Rubisco enzyme
CO₂ → unstable carbon 2. Phase 2 (light-independent)

b. Calvin Cycle ← use ATP (all)

C. Chloroplasts - disc-shaped organelles that contain two main compartments essential to photosynthesis

1. Thylakoids - flattened, saclike membranes arranged in stacks

a. Stacks are called grana

2. Stroma - fluid-filled space that is outside the grana

D. Pigments - light absorbing colored molecules found in thylakoid membranes of chloroplasts

1. Major light-absorbing pigments in plants = chlorophylls

E. Electron transport (1st step of photosynthesis)

→ know steps of electron transport (p. 453) Figure 10

F. Calvin Cycle (2nd phase of photosynthesis)

→ Figure 11 (pg. 455)

1. Enzyme Rubisco converts inorganic CO₂ molecules into organic molecules that can be used by the cell

a. This is known as carbon fixation
inorganic C → organic C

II Alternative Pathways

A. Many plants in extreme environments have alternative photosynthesis pathways

B. C_4 plants - fix CO_2 into 4 carbon compounds instead of 3 in Calvin Cycle

1. minimizes water loss

C. CAM (Crassulacean acid metabolism) plants

1. Occurs in dry areas where access to water is limited

2. Process allows CO_2 only to enter plant at night when atmosphere is cooler and there is less humidity

a. process also minimizes water loss

3. Carbon fixation at night of organic CO_2 molecules then enter Calvin Cycle during day to minimize water loss

Grade: 10th

- Subject: Biology

· Date:

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Grade: «grade»
Subject: «subject»
Date: «date»

1 Light absorbing colored molecules called _____ are found in chloroplasts.

A pigments

B stroma

C rubisco

D ATPs

2 Where do light-independent reactions occur during photosynthesis?

- A mitochondrion
- B stroma in vacuoles
- C nucleus

D stroma in thylakoids

3 What occurs in the second phase of photosynthesis?

- A chemiosmosis produces ATP
- B light absorbed
- C light is converted into ATP

D glucose is made from ATP



4 Which of these statements is true regarding chlorophyll?

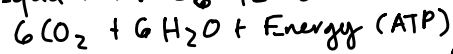
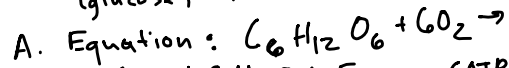
- ☒ A it is not the only photosynthetic pigment
- ☐ B there is only one kind of chlorophyll
- ☐ C it is the only type of pigment in leaves
- ☐ D it is the rarest type of pigment in leaves

5 Rubisco is the enzyme that converts inorganic carbon dioxide into organic carbon dioxide that can be used during the Calvin cycle.

Q.3 Cellular Respiration

I. Overview of Cellular Respiration

(harvest of electrons from compounds (glucose) to make ATP)



B. Two main parts: glycolysis + Aerobic respiration

1. Glycolysis = anaerobic (no O_2)

2. Krebs cycle + electron transport = aerobic resp. = (O_2 resp)

II Glycolysis

occurs in cytoplasm
A. Glucose is broken down into two molecules pyruvate (Process requires 2 ATP to begin process and provide phosphates to make two 3-carbon compounds)

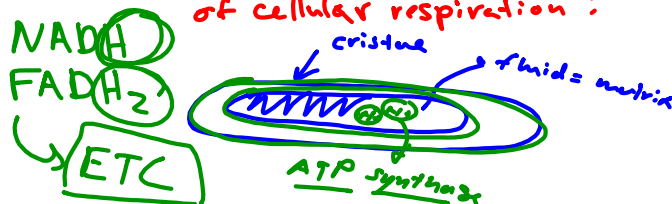
Rxn = reaction
1. Phosphates are yielded when $ATP \rightarrow ADP$
2. Process produces 4 ATP molecules but only yields 2 ATP since 2 ATP is needed to start rxn.

a. NADH molecules involved with reaction carry electrons to the electron transport chain

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→ How does the structure of the mitochondrion allow it to make energy?

→ What are the 3 key parts of cellular respiration?



Cell Respiration Review

Grade: 10th

Subject: Biology

Date:

1 In lactic acid fermentation, _____ is converted into lactic acid.

A alcohol

B pyruvate

C citric acid

D sunlight

glucose \rightarrow glyceraldehyde $\xrightarrow{\text{pyruvate}}$ fermentation \rightarrow lactic acid
no O_2 \rightarrow pyruvate \rightarrow Krebs \rightarrow ETC

2 What cellular process actually produces most of the ATP?

A absorption of light

B Krebs cycle

C fermentation

D electron transport

→ NADH
FADH₂

3 What anaerobic process occurs after glycolysis?

A electron transport

B Krebs cycle

C fermentation

D prokaryotic respiration

4 Glycolysis is a(n) _____ process in the first stage of ~~photosynthesis~~
cell resp.

A aerobic

B anaerobic

C non-metabolic

D non-energy

.

5 What do cells store and release as the main source of chemical energy?

A ATP

B ADP

C NADP+

D NADPH

.

Bellringer

- What is the relationship between photosynthesis and cellular respiration?
products of one are the reactants for other
- What is the chemical equation for cell respiration?

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{light}} 6CO_2 + 6H_2O + \boxed{ATP}$$
- What are the 3 parts of cell respiration?

$$\text{Glycolysis} \rightarrow \text{acetylcoa} \rightarrow \text{Krebs cycle} \rightarrow \text{ETC}$$
- What are the roles of $NADH$ and $FADH_2$ in cell respiration?

$$\begin{array}{ccc} + & + & + \\ + & + & \end{array} \xrightarrow{\text{ATP synthase}} \times$$

Grade: 10th

Subject: Biology

Date:

1 Metabolism is the energy currency of the cell.

True

False

.

2 The study of the flow and transformation of energy is called thermodynamics.

True

False

.

3 Chemical reactions that convert energy within a cell are referred to as metabolism.

☒ True

☐ False

4 Which is not a characteristic of energy?

A cannot be created nor destroyed

B is the capacity to do work

C exists in forms such as chemical, light, and mechanical

☒ D changes spontaneously from disorder to order

5 Which organism depends on an external source of organic compounds?

A autotroph

B heterotroph

C chemoautotroph

D photoautotroph

.

6 What do cells store and release as the main source of chemical energy?

A ATP

B ADP

C NADP+

D NADPH

.

7 The location of the light reactions during photosynthesis is the thylakoid.

True

False

8 A colored molecule that absorbs light is a _____.

chlorophyll
pigment

9 A process in which energy is stored in organic molecule is the Calvin cycle.

True

False

.

10 What waste product of photosynthesis is released to the environment?

A carbon dioxide

B water

C oxygen

D ammonia

-

11 Which is the internal membrane of the chloroplast that is organized into flattened membranous sacs?

- A thylakoids
- B mitochondria
- C theca
- D stroma

12 Which supplies energy used to synthesize carbohydrates during the Calvin cycle?

- A CO_2 and ATP
- B ATP and NADPH
- C NADPH and H_2O
- D H_2O and O_2

13 Pyruvate is broken down into carbon dioxide during the Krebs cycle.

.

14 _____ processes occur in the absence of oxygen.

Anaerobic

.

15 The two main types of fermentation are ~~pyruvate~~^{lactic acid} fermentation and alcohol fermentation.

True

False

.

16 Glucose is broken down during the process of glycolysis.

Sugar
(glucose) split

.


17 Which cell organelle is the site of cellular respiration?

- A Golgi apparatus
- B mitochondrion
- C nucleus
- D endoplasmic reticulum

18 Which is not a stage of cellular respiration?

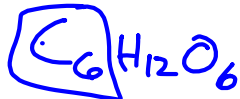
- A glycolysis
- B Krebs cycle
- C electron transport chain
- D lactic acid fermentation

19 What is produced when the electrons leave the electron transport chain in cellular respiration and bind to the final electron acceptor for the chain?

- A H_2O 
- B O_2 *donor*
- C CO_2
- D $NADPH$

20 Which step occurs during the Calvin cycle?

- A formation of ATP
- B formation of six-carbon sugars
- C release of oxygen gas
- D transport of electrons by $NADP^+$



21 Which energy transformation can occur only in autotrophs?

- A chemical energy into mechanical energy
- B electrical energy into thermal energy
- ☒ C light energy into chemical energy
- D mechanical energy into thermal energy

22 A stack of thylakoids is a granum.

- ☒ True
- ☐ False

III Kreb's cycle (or TCA or Citric acid cycle)

→ this occurs in the mitochondria

A. Process is the conversion of the two pyruvate from glycolysis acetyl CoA that cycles through a series of chemical rxns to make (yield) energy

B. Process yields 6 O_2 , 2 ATP, 8 NADH, and 2 $FADH_2$

→ see Figure 15 p. 463

IV Electron transport (final step of cell resp.)

A. Process produces energy by using high-energy electrons and hydrogen ions to power the conversion of $ADP \rightarrow ATP$

B. Process yields 32 ATP

C. Process occurs in mitochondrial membrane
→ Figure 17 p. 467

V Prokaryotic cellular respiration

A. Process does not require pyruvate to travel to mitochondria, requiring less energy input

1. Prokaryotic cell resp yields 38 ATP

VI Anaerobic respiration (no O_2)

A. Two main types: lactic acid + alcohol fermentation

B. Follows glycolysis

→ see Figure 18

VII Photosynthesis + Cell Respiration

A. Products of photosynthesis = O_2 + glucose which are reactants for cell resp.

B. Products of cell resp. = CO_2 + H_2O which are the reactants for photosynthesis